METHOD FOR CORRECTING A POSITION SENSOR, DELAY BETWEEN THE PASSAGE OF A MAGNETIC ELEMENT AND A DETECTED LOGIC SIGNAL, AND SENSOR USED THEREFOR

The subject of the present invention pertains to the technical area of magnetic sensors of the type comprising an encoding element moving in the vicinity of at least one detection system, adapted to identify at least one angle position in the general meaning.

The subject of the invention finds particularly advantageous applications in the automotive sector in which said sensor can be used to detect the position of a mobile for example, in particular part of the ignition functions or gear changes.

In the prior art, it is known to use a magnetic sensor adapted to measure the change in intensity of a magnetic field when an encoder, associated with the mobile whose position is to be determined, travels in front of a detection system comprising one or more measurement or detection cells. The encoder is provided with at least one element generating a variable magnetic field having two magnetic transitions that are separated from each other over a given width. Each detection cell, such as a Hall Effect Probe or magnetoresistive sensor, delivers a periodic signal corresponding to changes in intensity of the magnetic field generated by the generator elements. Each detection cell is associated with a hysteresis level comparator such as a Schmitt trigger to obtain a logic electric signal comprising switching edges for separate values of the magnetic field according to whether it varies increasingly or decreasingly.

In various applications such as a rotation sensor, there exists a major drawback regarding the phase difference existing between the passing of the magnetic transitions of the generator elements and the position of the switching edges

of the logic electric signal delivered by the detection system.

Said drawback is apparent for example in the case when the position of the mobile to be identified is of narrow width in the direction of movement. This is particularly the case with the gear change lever in a motor vehicle. According to this application, it is sought to obtain a logic signal of which one status represents a particular position or group of positions, whereas the other status represents the other positions. It can be considered to detect the “neutral” position by logic status 0 and the other positions by logic status 1. For this purpose, the encoder is provided as a magnetized support linked to the gear lever and comprising an element generating a magnetic field having magnetization in the opposite direction to the adjacent areas. Yet the position of the switching point heavily depends upon the value of the air gap between the encoder and the detection cell, which means that in practice there is a variation in the air gap making it impossible to guarantee the reliable detection of the mobile’s position.

The above-mentioned drawback is also apparent for a position sensor adapted to be compatible with the True Power On (TPO) function, i.e. the ability to allow the determination, as soon as the sensor is switched on, of the position of the generator element with respect to the detection cell. The disadvantage of said sensor is that it detects the generator element i.e. the cog after it has moved away from the sensor and before it draws close to it, which gives rise to a major phase difference between the electric signal and the passing of the encoder cog since the falling switching edge of the signal is too late with respect to the passing of the cog, whereas the rising switching edge is too early.

The object of the present invention is therefore to overcome the above-mentioned disadvantages by proposing a method with which it is possible, for a position sensor, to correct the phase difference between the passing of a magnetic element in front a detection system and the detected logic signal.

To reach said objective, the subject of the invention sets out to propose a method of correcting, for a position sensor, the phase difference between firstly the relative passing of at least one first and one second magnetic transition of an element generating a variable magnetic field in front of a detection system comprising at least two detection cells, and secondly the position of at least two switching edges of a logic electric signal delivered by the detection system, the two magnetic transitions being separated from each other by a given width in the direction of relative movement between the generator element and the detection system.

According to the invention, the method consists of:

• choosing the form of a reference logic electric signal by determining the position of at least one first and one second variation edge,

• separating the detection cells in the direction of movement by a given value so that one cell detects at least the first magnetic transition to obtain a logic signal with at least one switching edge corresponding to the determined position of the first variation edge, whilst the other cell detects at least the second magnetic transition to obtain a logic signal with at least one switching edge corresponding to the determined position of the second variation edge,

• and of combining the logic signals delivered by the detection cells so as to obtain a logic electric signal corresponding to the reference electric signal.

According to a first variant of embodiment the method of the invention consists of:

• choosing the form of a reference logic electric signal corresponding to the passing in front of the detection system by a reference generator element having a given width smaller than the width of the generator element passing in front of the detection system, and

• spacing the detection cells so that the logic electric signal obtained is in phase with the passing of the reference generator element in front of the detection system.

Advantageously the method consists of providing the generator element with magnetization in the opposite direction to that of the areas adjacent to said generator element.

According to this first variant of embodiment, the method consists of combining the logic signals delivered by the detection cells taking into account those parts of the signals simultaneously having one same logic status between the switching edges, with a view to obtaining the logic electric signal in phase with the passing of the reference generator element.

According to a second variant of embodiment, the method consists of:

• choosing the form of a reference logic electric signal corresponding to the passing of a generator element in front of the detection system and

• spacing the two detection cells so that the logic electric signal obtained is in phase with the passing of a generator element.

According to this second variant of embodiment, the method consists of combining the logic signals delivered by the detection cells taking into account those parts of the signals simultaneously having one same logic status between

the switching edges, with a view to obtaining a logic electric signal in phase with the passing of a generator element.

Advantageously, the inventive method consists of using the logic signals delivered by the detection cells with a view to determining the direction of rotation of the generator element.

A further purpose of the invention is to propose a sensor comprising at least one element generating a variable magnetic field comprising a first and second magnetic transition, and intended to travel in front a detection system comprising at least two detection cells and delivering a logic electric signal comprising at least two switching edges and corresponding to changes in the magnetic field generated by the element, the detection cells being linked to means for processing electric signals delivered by the detection cells.

According to the invention, the detection cells are spaced apart in the direction of relative movement between the generator element and the detection system, by a given value so that one cell detects at least the first magnetic transition to obtain a logic signal with at least one switching edge corresponding to the position determined for the first variation edge, whilst the other cell detects at least the second magnetic transition to obtain a logic signal with at least one switching edge corresponding to the position determined for the second variation edge, and in that the processing means combine the electric signals of the detection cells so as to obtain a logic electric signal corresponding to a reference electric signal.

According to a first variant of embodiment, the detection cells are spaced by a given value so that the logic electric signal obtained is in phase with the passing of a reference generator element having a given width smaller than the width

of the generator element and which allows the obtaining of the reference electric signal.

The processing means combine the logic signals delivered by the cells taking into account those parts of the signals simultaneously having one same logic status between the switching edges, with a view to obtaining the logic electric signal in phase with the passing of the reference generator element.

According to a second variant of embodiment, the detection cells are spaced by a given value so that the logic electric signal obtained is in phase with the passing of a generator element.

Advantageously, the processing means comprise means for using the logic signals delivered by the detection cells with a view to determining the direction of rotation of the generator element.

Various other characteristics will become apparent on reading the following description with reference to the appended drawings which, as non-limitative examples, illustrate forms of embodiment of the subject of the invention.

Figure 1 is a perspective view showing a characteristic detail of an encoder used in a first application of the inventive position sensor.

Figure 2 is a view on a larger scale showing the encoder illustrated Fig.1 with which measurement chronograms are associated.

Figure 3 gives a view of a reference encoder associated with a measurement chronogram.

Figure 4 shows different measured chronograms under a second application of an inventive position sensor.

Figures 1 and 2 illustrate a first example of application of the subject of the invention with a position sensor 1 able

to detect the position of a mobile element in two degrees of freedom and to provide information representing an area in which the mobile element is located. The degrees of freedom of the mobile may be translation along two axes defining a translation plane, rotation about two axes or, as in the illustrated example, the combination of a translation represented by arrow T and a rotation R along axis O. One possible application is the identification of a particular position of a mobile such as a gear change lever in a motor vehicle for example.

According to this example of embodiment, the position sensor 1 comprises an encoder 3 containing at least one, and in the illustrated example one element 5 generating a variable magnetic field, intended to travel in front of a detection system 6. In the illustrated example, the encoder 3 consists of a magnetized drum carrying a generator element 5 such as a magnetization pattern of opposite direction to the direction of magnetization of the adjacent areas. This generator element 5 therefore comprises a first T_1 and second T_2 magnetic transition in the direction R of relative movement between element 5 and the detection system 6.

According to the invention, the detection system 6 comprises a first 6_1 and second 6_2 detection or measurement cell which each deliver an analog electric signal corresponding to changes in the intensity of the magnetic field delivered by the encoder 3. The output of detection cells 6_1, 6_2 is connected to means, not shown, for processing electric signals delivered by the cells making it possible to obtain logic electric signals.

According to this example of embodiment, it is to be considered that the size of the area to be distinguished is small along direction R. Therefore the measurement of induction made by cells 6_1, 6_2 is highly sensitive to variation

in the air gap i.e. the distance between the generator element 5 and the cells 6_1, 6_2. Therefore the switching edges of the logic electric signals, with respective low and high air gap, change. To overcome this disadvantage the object of the invention is to provide a generator element 5 having a greater width than the generator element corresponding to the area to be detected.

In other words, the object of the invention, as illustrated more particularly Fig. 3, is to choose the form of a reference logic electric signal S_r by determining the position of at least one first Fv_1 and one second Fv_2 variation edge corresponding to the passing of the magnetic transitions of a reference generator element 5_r having a width adapted to the area to be detected. In other words, the inventive method consists of taking into account the position of the variation edges Fv_1, Fv_2 of a logic signal obtained by the passing of a so-called reference generator element 5_r in front of the detection system, the width of this generator element corresponding to the area in which the position of the mobile is to be identified.

Another aspect of the invention is to space the detection cells 6_1, 6_2 in the direction of movement R by a given value so that one cell e.g. 6_2 is able to obtain the position of a variation edge such as Fv_1 whilst the other cell, namely 6_1, is able to allow obtaining of the position of the other variation edge, namely Fv_2. As shown clearly Fig.2, each cell 6_1, 6_2 makes it possible to obtain a logic electric signal S_1, S_2 shifted by the value of their spacing and each comprising switching edges (Fc_1', $Fc_2 - Fc_1$, Fc_2') corresponding to the passing of the magnetic transitions T_1,T_2. According to the invention, the logic electric signals S_1, S_2 respectively obtained by cells 6_1, 6_2 respectively comprise at least one switching edge Fc_2, Fc_1 respectively corresponding to the

positions of the second Fv_2 and first Fv_1 variation edges of the reference logic signal S_r.

As arises from the preceding description, the spacing between cells 6_1, 6_2 and the width between the magnetic transitions T_1, T_2 of the generator element 5 are chosen so that each cell takes part in locating a variation edge of the reference logic signal S_r.

According to the invention, the processing means combine the logic signals S_1, S_2 obtained by the detection cells 6_1, 6_2 so as to produce a logic electric signal S_t corresponding to the reference electric signal S_r. In the illustrated example, the processing means therefore take into account those parts of signals S_1, S_2 simultaneously having one same logic status between the switching edges Fc_1, Fc_2 to obtain the logic electric signal S_t in phase with the passing of the reference generator element 5_r. In the illustrated example, the two logic electric signals S_1 and S_2 are combined by means of a logic OR gate so as to obtain the logic signal S_t.

It arises from the preceding description that the inventive method consists of choosing the form of a reference logic electric signal S_r corresponding to the passing in front of the detection system 6 by a reference generator element 5_r having a given width corresponding to the area to be detected and smaller than the width of the generator element 5 actually passing in front of the detection system 6. Insofar as the generator element 5 is of greater width than the reference generator element 5_r which should have been provided to detect the position of the mobile, the sensor appears to show little sensitivity to variations in the air gap.

The object of the invention is also application to a position sensor compatible with the True Power On (TPO) function. In this application, it is known to provide the

encoder with a series of elements 5 generating a variable magnetic field, arranged regularly around a circumference.

According to a first known form of embodiment, the generator elements 5 consist of elements disturbing a magnetic field set up by a fixed magnet positioned in the vicinity of said disturbing elements. For example said disturbing elements consist of cogs arranged in a ferromagnetic ring. According to a second form of embodiment the elements generating a variable magnetic field are formed by magnetic poles regularly spaced apart by a given pitch. Said encoder is therefore in the form of a multipolar magnetic ring.

According to this application, the object of the invention consists of choosing the form of a reference logic electric signal S_r, corresponding to the passing of generator elements 5 in front of the detection system 6 so that the magnetic transitions T_1, T_2 of each generator element 5 are in phase with the switching edges Fv_1, Fv_2 of the logic electric signal S_r.

According to the invention, the two detection cells 6_1 and 6_2 are spaced so that the logic electric signal S_t obtained is in phase with the passing of each generator element 5. Therefore, as clearly illustrated Fig.4, the detection cells 6_1, 6_2 are spaced apart in the direction of movement so that one cell e.g. 6_2 detects at least the first magnetic transition T_1 to obtain a logic signal S_2 with at least one switching edge Fc_1 corresponding to the position determined for the first variation edge Fv_1, whilst the other cell 6_1 detects at least the second magnetic transition T_2 to obtain a logic signal S_1 with at least one switching edge Fc_2 corresponding to the position determined for the second variation edge Fv_2.

The logic signals S_1, S_2 delivered by the detection cells are combined by taking into account those parts of the signals

simultaneously showing one same logic status between the switching edges Fc_1, Fc_2 with a view to obtaining the logic electric signal S_t comprising the variation edges Fv_1, Fv_2 and in phase with the passing of each generator element 5.

According to one characteristic of the invention provision is made to use the logic signals delivered by the detection cells with a view to determining the direction of movement of the generator element. The presence of logic signals S_1, S_2 slightly out of phase with each other, allows easy determination of the direction of movement. Persons skilled in the art know for example the use of a trigger D to achieve this type of function taking into consideration the logic status of one of the two signals e.g. S_2 at the time of the rising edge of the other signal, namely S_1. In this case the output of trigger D, at the time of the rising edge of signal S_1, assumes a high or low logic status representing the direction of movement. Evidently it could be considered to use more sophisticated logic processing to detect direction of movement with a view to obtaining more rapid information on the direction of movement.

The invention is not limited to the described, illustrated examples since various modifications may be made thereto without departing from the scope thereof.